DOCTOR MOLE INCORPORATED

SELECTION OF TUNNEL METHODS

By: Dr. Gary S. Brierley

Successful Tunnel "Design"

Produce a satisfactory finished facility for no more money and in no more time than is required for the **existing ground conditions**.

DOCTOR MOLE INCORPORATED

Tunnels are Different than Above-Ground Structures

- ✓ Entirely within the ground.
- ✓ The ground cannot be specified.
- ✓ The ground can be changed.
- ✓ Serial Construction Schedule.

DOCTOR MOLE INCORPORATED

Tunnels are Different than Above-Ground Structures

- Work from inside/out.
- The ground requires temporary support.
- Lots of third party impacts.
- Land not owned by project.

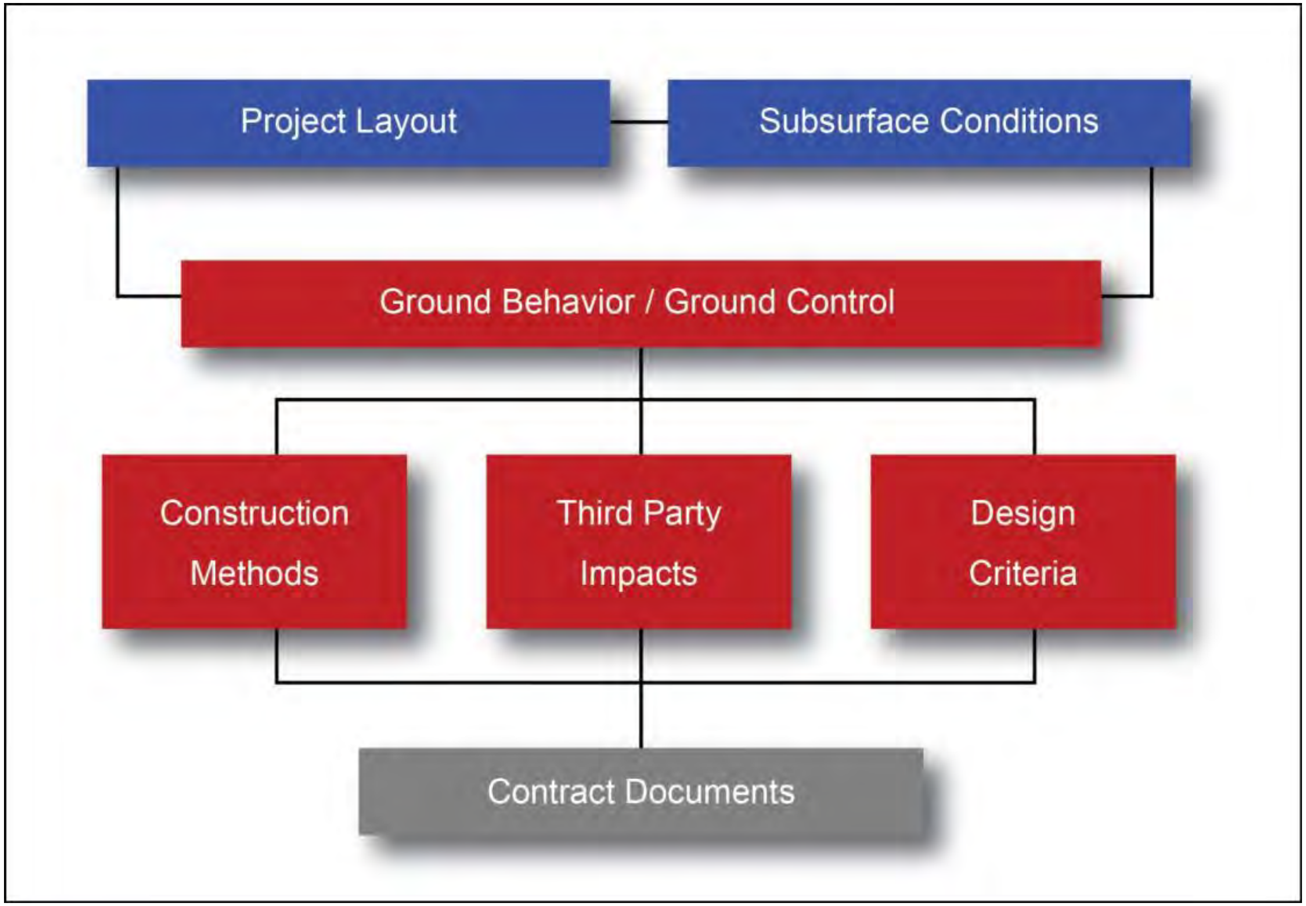
DOCTOR MOLE INCORPORATED

Building a Tunnel

- ✓ **Excavate** the ground
- ✓ **Control** the ground during the process of excavation.
- ✓ **Support** the ground as the tunnel is advanced.
- ✓ **Install** the final lining.

DOCTOR MOLE INCORPORATED

Evaluating Tunneling Issues



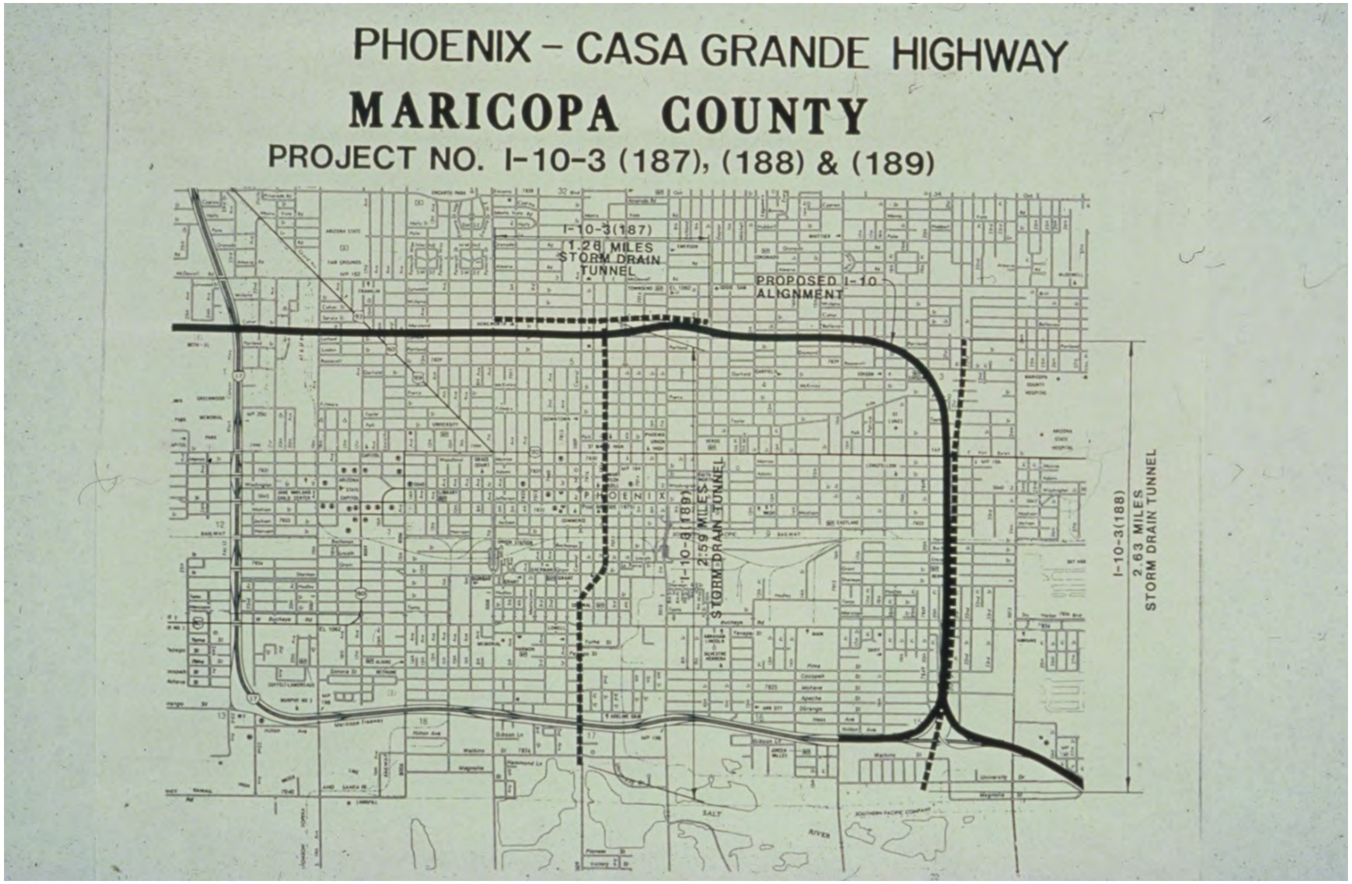
Risk Management

- ✓ The Geotech
- ✓ The Designer
- ✓ The Contractor
- ✓ The Owner
- ✓ Third Parties
- ✓ Insurers, etc.

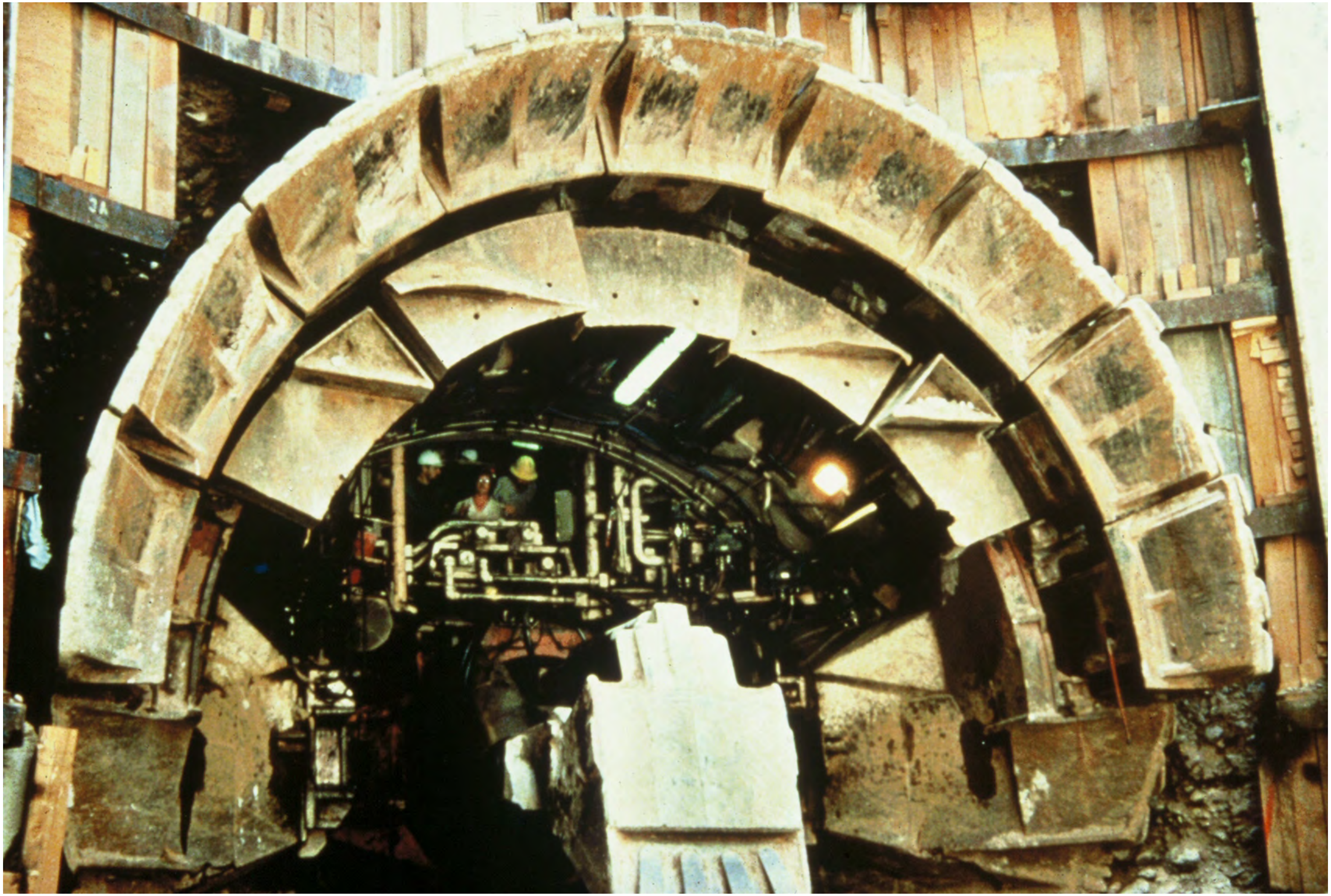
DOCTOR MOLE INCORPORATED

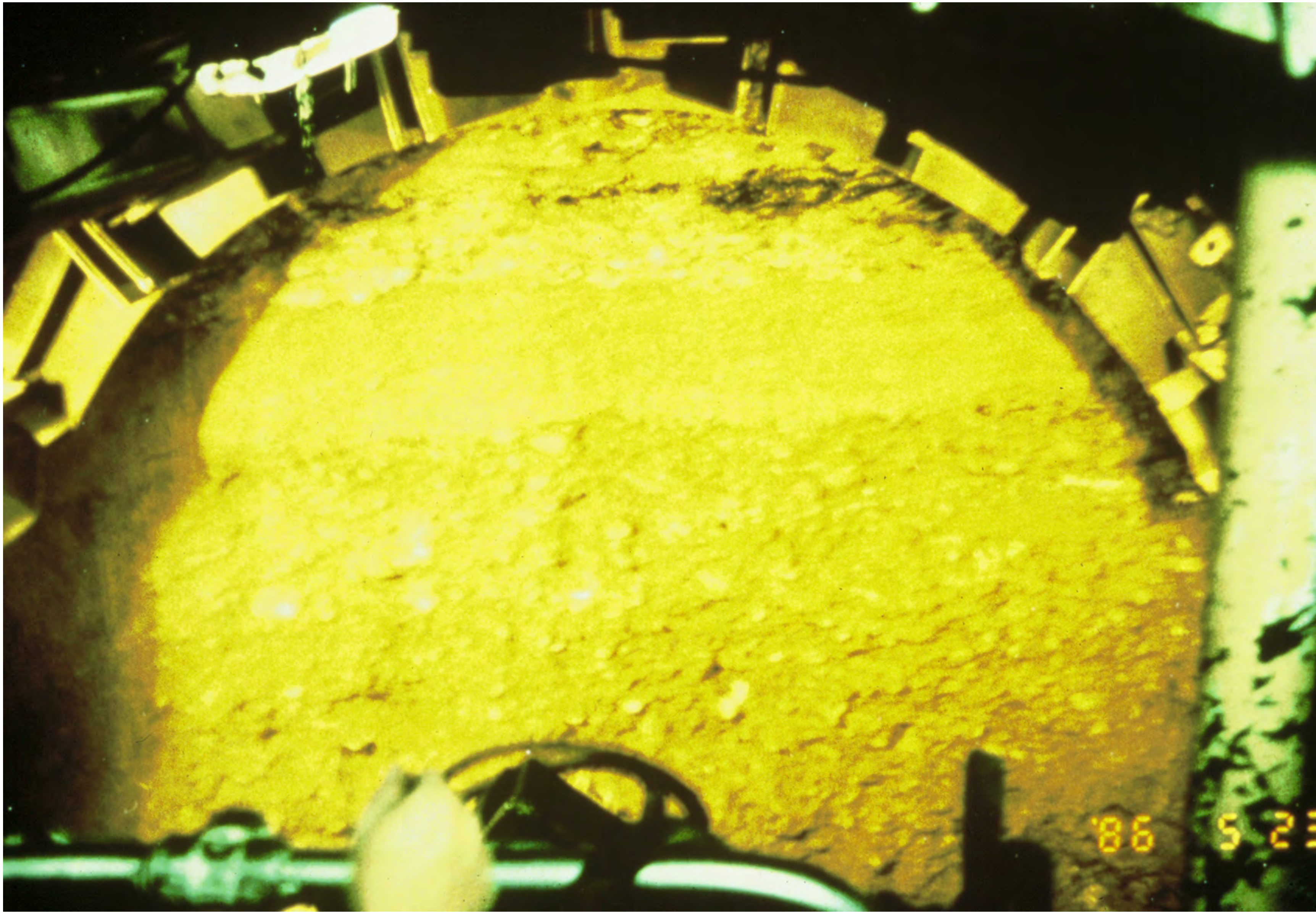
Case Histories

Phoenix Casa Grande Highway



DOCTOR MOLE INCORPORATED

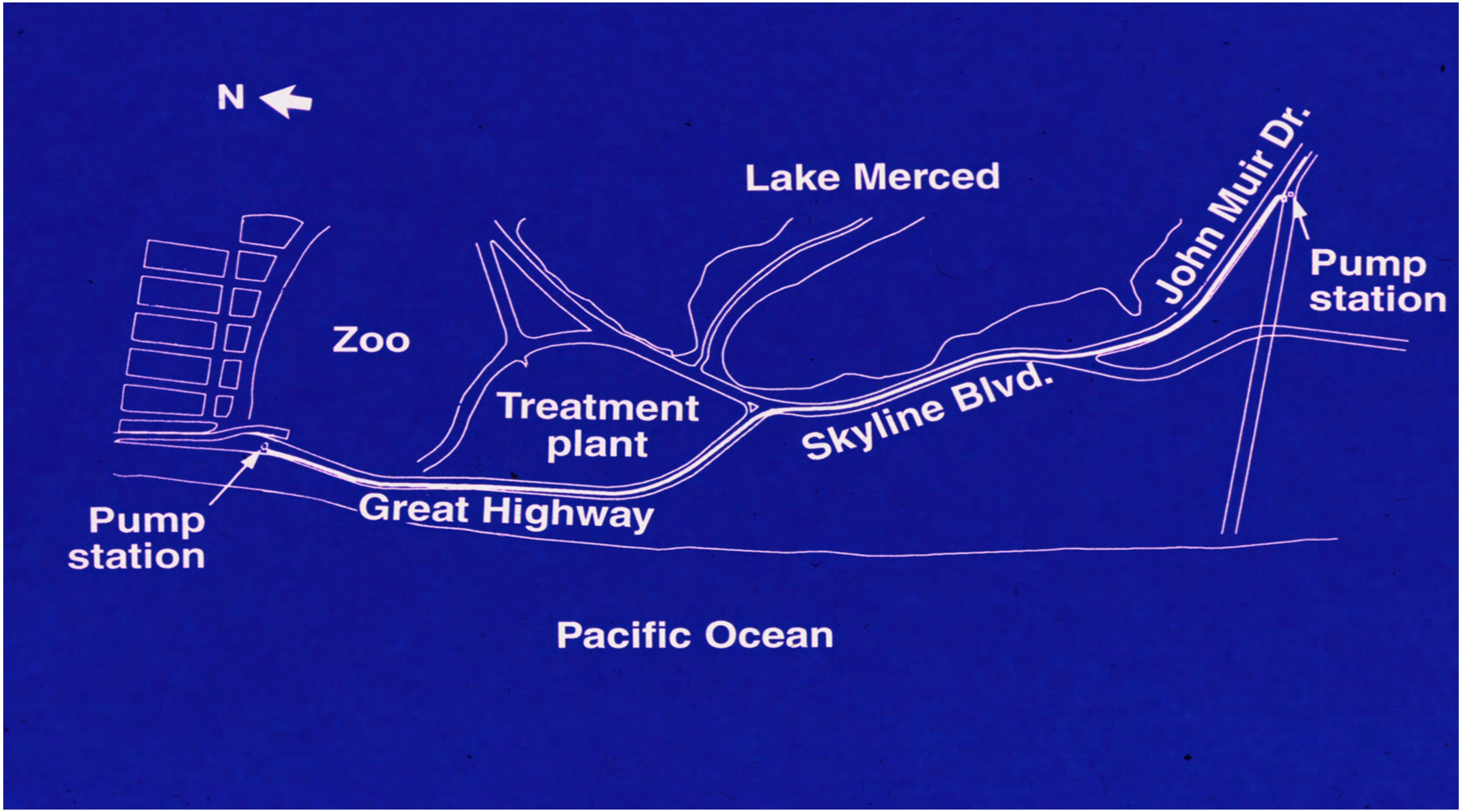



'86 5 23


12 13:45


JACOBY & MEYERS


25525
MEGA
FLEET
SULLIVAN
PARKING
PERMIT
REQUIRED

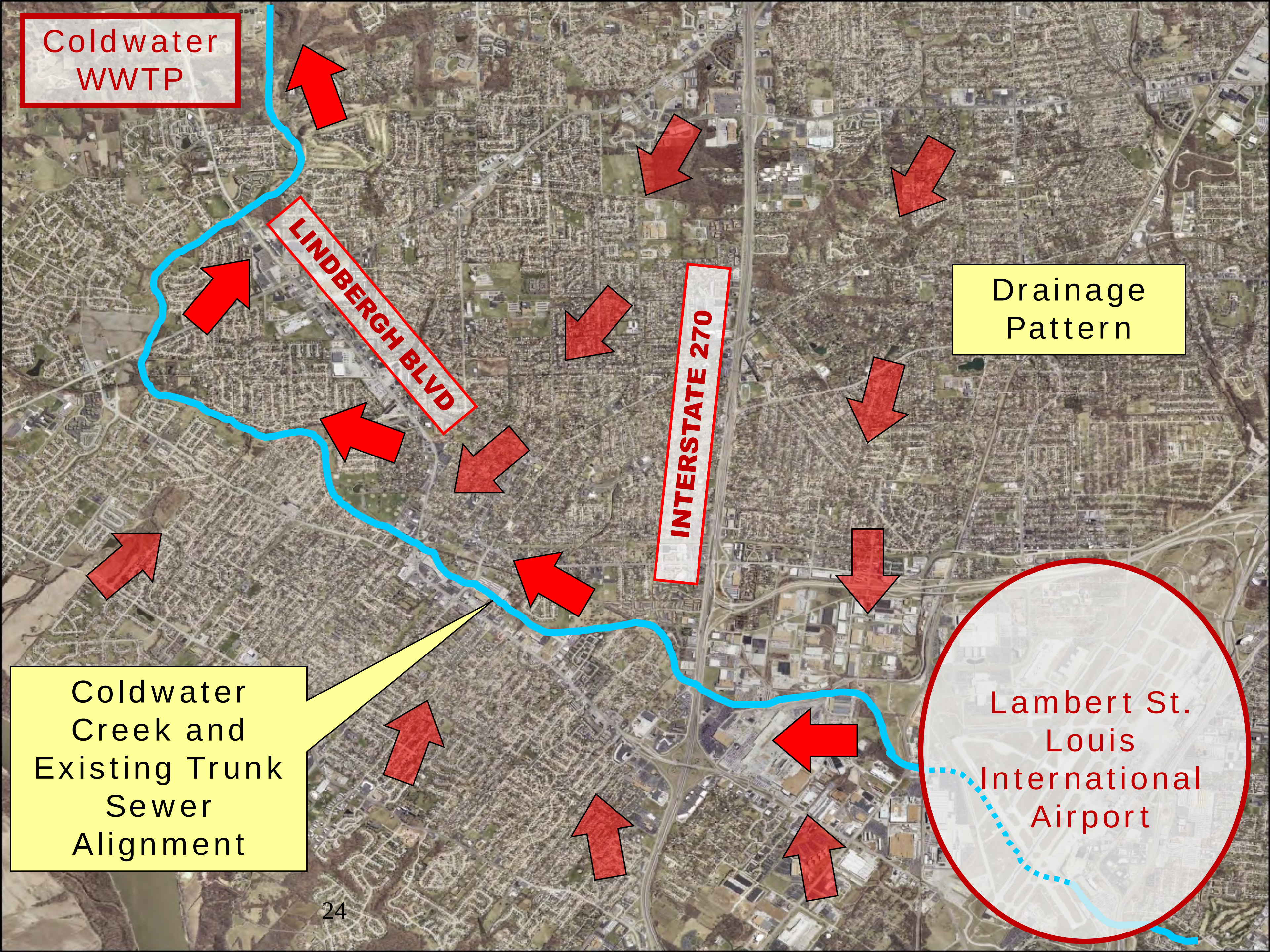

N
Lake Merced
John Muir Dr.
Pump station
Zoo
Treatment plant
Skyline Blvd.
Great Highway
Pump station
Pacific Ocean

Coldwater Sanitary Relief Project

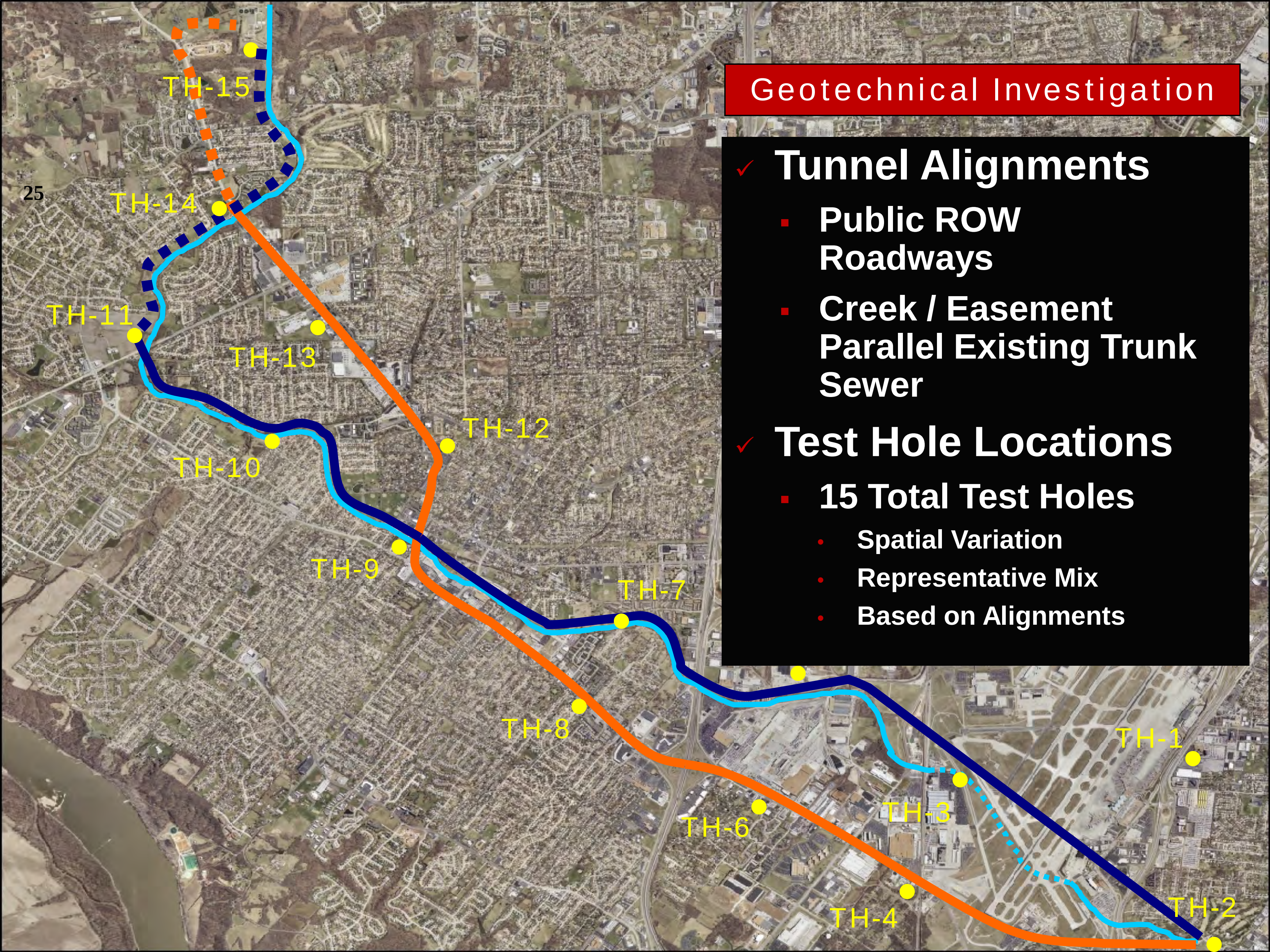
MSD

CMT
CRAWFORD, MURPHY & TILLY, INC.
CONSULTING ENGINEERS

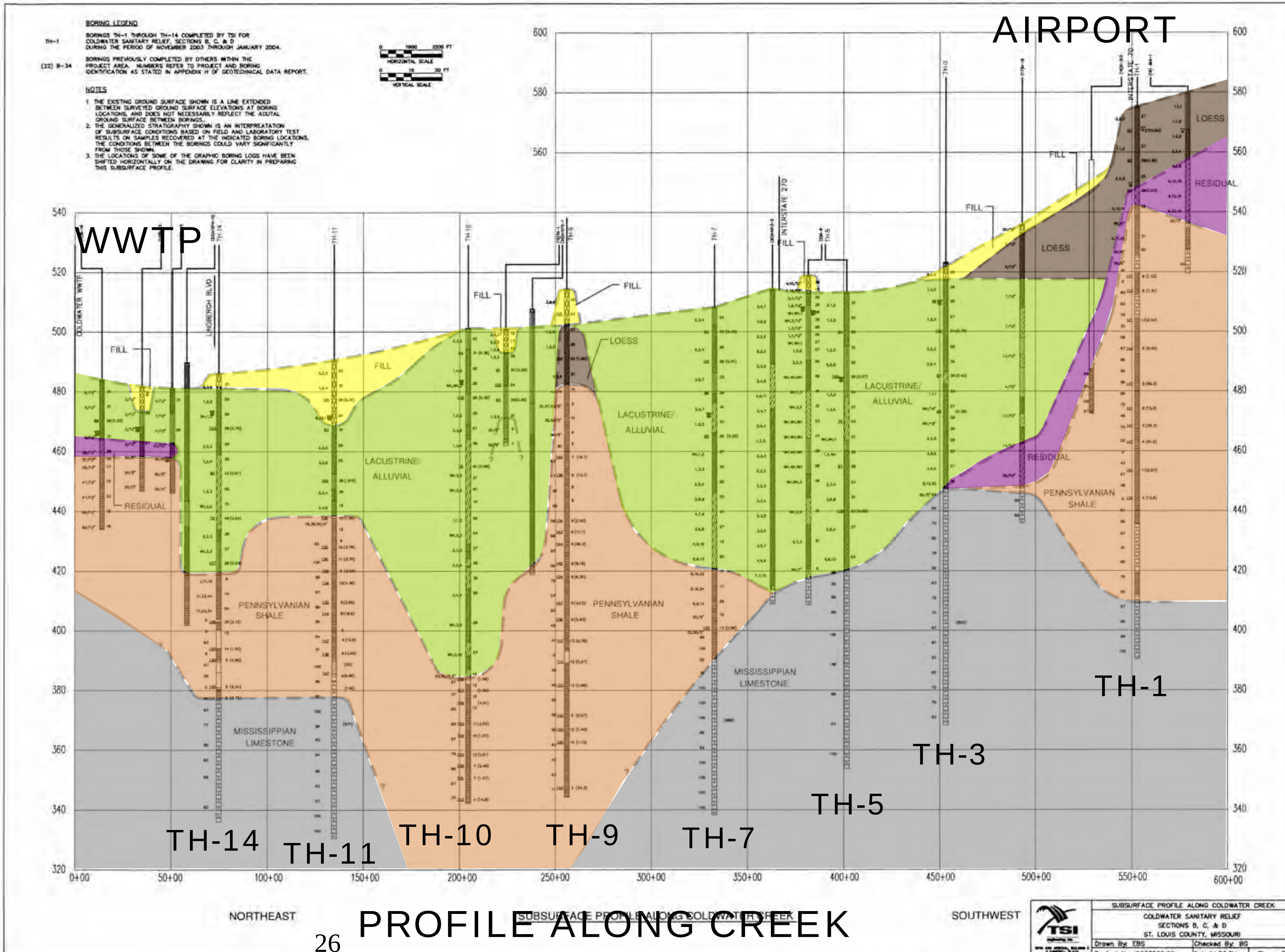
DOCTOR MOLE
INCORPORATED


Coldwater WWTP
LINDBERGH BLVD
INTERSTATE 270
Drainage Pattern
Coldwater Creek and Existing Trunk Sewer Alignment
Lambert St. Louis International Airport

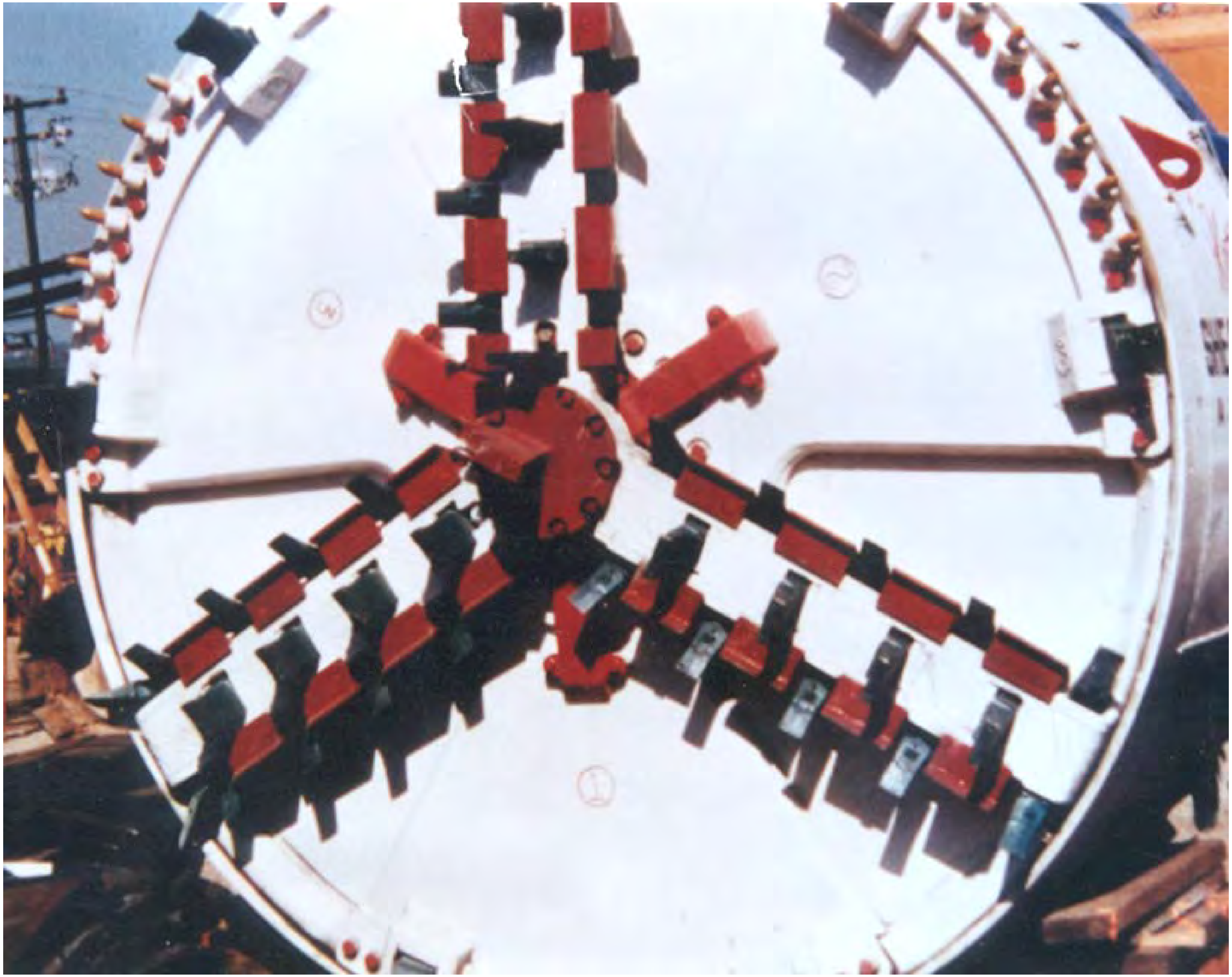
Geotechnical Investigation



- **Tunnel Alignments**
  - **Public ROW Roadways**
  - **Creek / Easement Parallel Existing Trunk Sewer**
- **Test Hole Locations**
  - **15 Total Test Holes**
    - **Spatial Variation**
    - **Representative Mix**
    - **Based on Alignments**



PROFILE ALONG CREEK



South Austin Regional Wastewater Treatment Plant

Presented By:

Kevin Koeller, P.E.

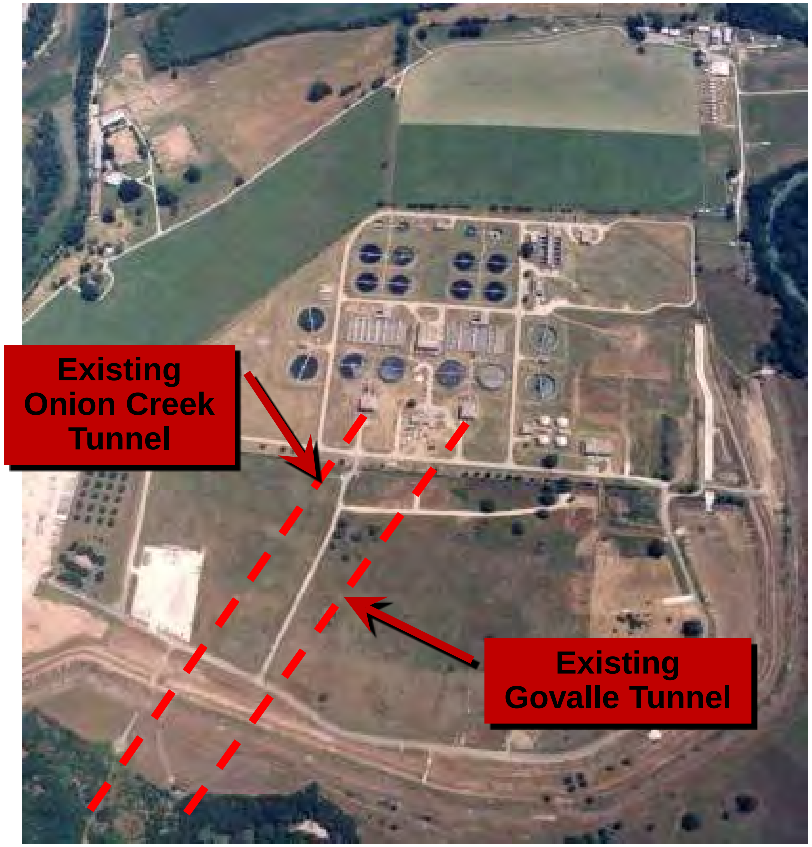
Gary Brierley, P.E.

Tunneling Through Backfill and Lift Station Walls Without Disturbing Plant Operations

DOCTOR MOLE INCORPORATED

Project Background

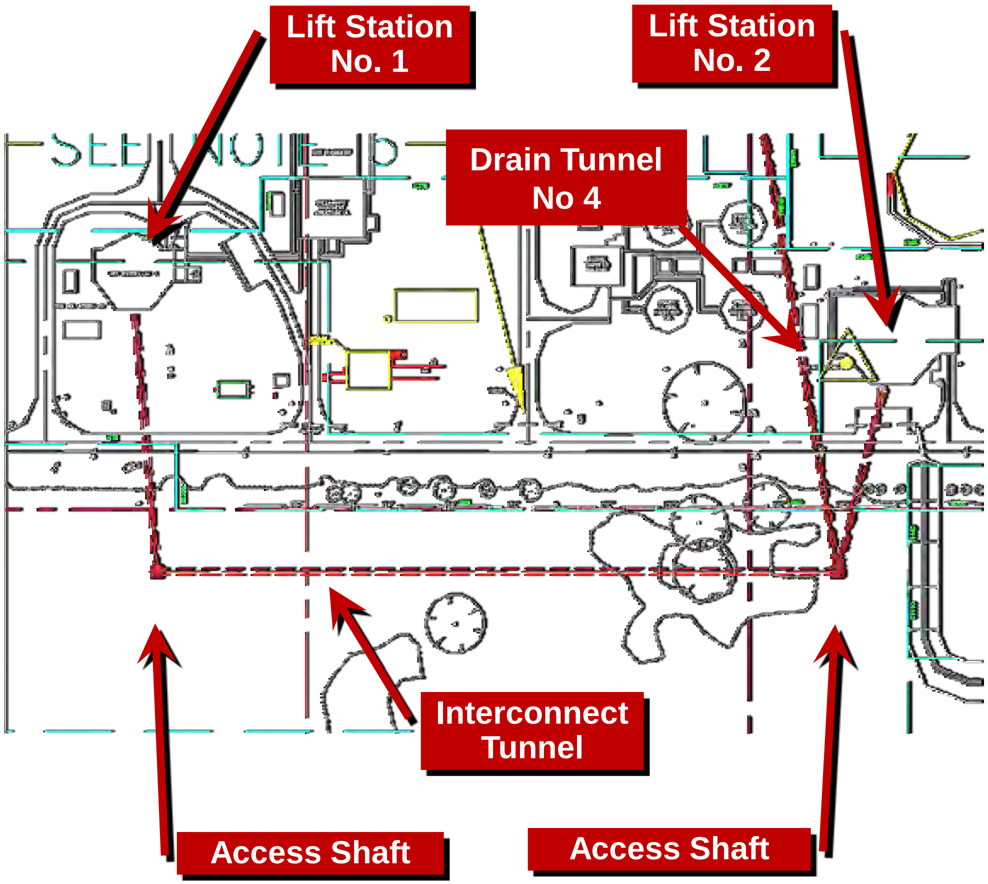
- SARWWTP receives flow from the south half of Austin (SAR Service Area)
- PER confirmed flow from service area
- Flow from two separate service areas is delivered to the site via two tunnels
- Tunnels terminate in two separate lift stations approximately 90 feet deep
- No definition of division of flow



DOCTOR MOLE INCORPORATED

Tunnel Route

- ✓ Avoid Damage to Operating Facilities
- ✓ Minimize Interruptions of Plant Operations
- ✓ Tunnel Must be Constructible



DOCTOR MOLE INCORPORATED

Tunnels Between Access Shafts No. 2

- Access Shaft 1 to Access Shaft 2 – 768 ft
- Decker Model 70 TBM – 5.75 ft dia
- Hobas Pipe – 63 in.
- Downhill - 0.2%
- Taylor Shale

DOCTOR MOLE INCORPORATED

Backfill of Existing Lift Stations

- Probing Operations
- Compaction Grouting

DOCTOR MOLE INCORPORATED

Saguaro Ranch Tunnel

DOCTOR MOLE INCORPORATED

Portal Cut

DOCTOR MOLE INCORPORATED

Horizontal Boring

Pilot Tunnel

DOCTOR MOLE
INCORPORATED

Shotcrete

Top Heading

DOCTOR MOLE
INCORPORATED

Final Tunnel

Grand & Bates Sewer Relief Tunnel

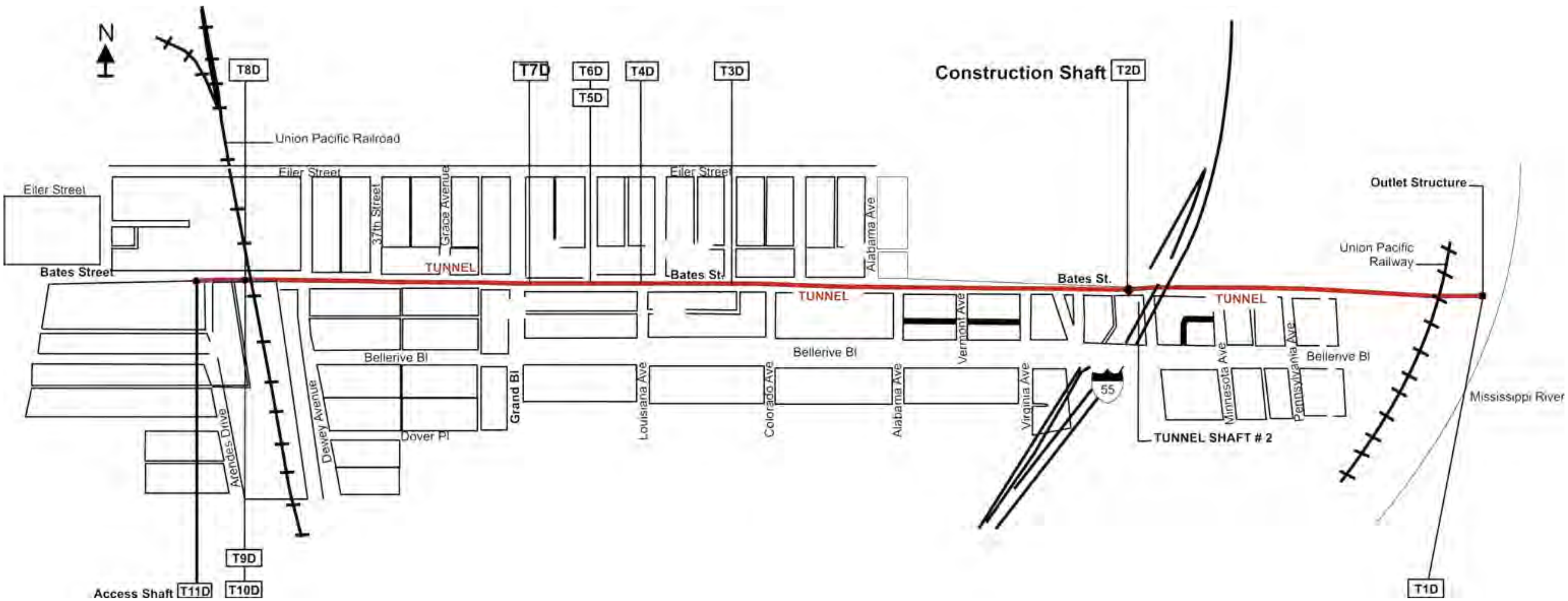
MSD

TSi
engineering, inc.

GEOTECHNOLOGY INC
FROM THE GROUND UP

DOCTOR MOLE
INCORPORATED

Tunnel Alignment



Grand & Bates / Plan View

Subsurface Conditions

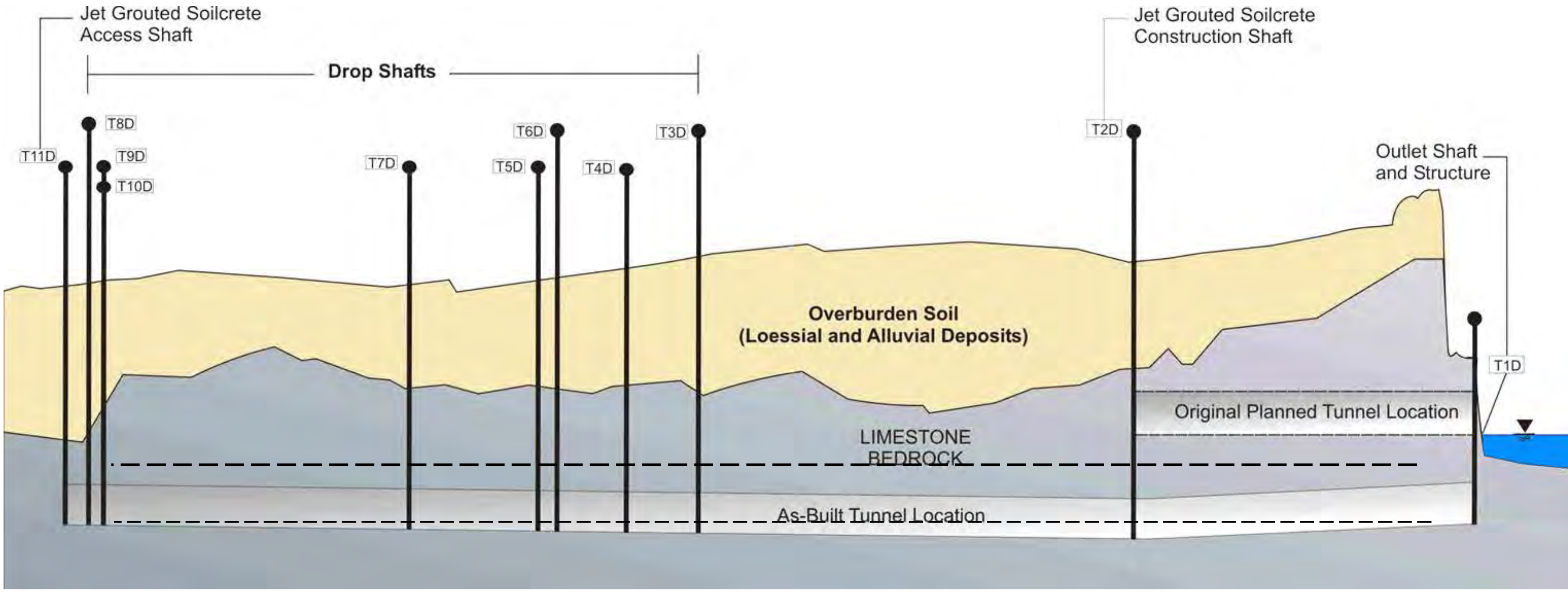
- ✓ **Overburden Soil**
  25 to 75 ft. fill/loess/alluvial soils
  Rubble fill (rip rap) at Outfall Structure

- ✓ **Highly Weathered Limestone**
  Low quality fractured zones with shale seams
  Pinnacled surface/karst potential
  k = 2.5 x 10-3 cm/sec

- ✓ **Unweathered St. Louis Limestone**
  White-light Gray, thin-massive bedding
  Chert lenses and nodules
  k = 1.5 x 10-5 cm/sec

DOCTOR MOLE INCORPORATED

VE Proposed Alternative Alignment



Simplified Alignment Reduces Construction Time, Effort, and Cost

DOCTOR MOLE INCORPORATED

Increased Tunnel Diameter

132-in Precast Concrete Liner Pipe increases storage volume by over 40%

DOCTOR MOLE INCORPORATED

Limited Use of Drill & Blast

Drill-Blast Starter Tunnel Used to Permit Assembly of TBM

DOCTOR MOLE INCORPORATED

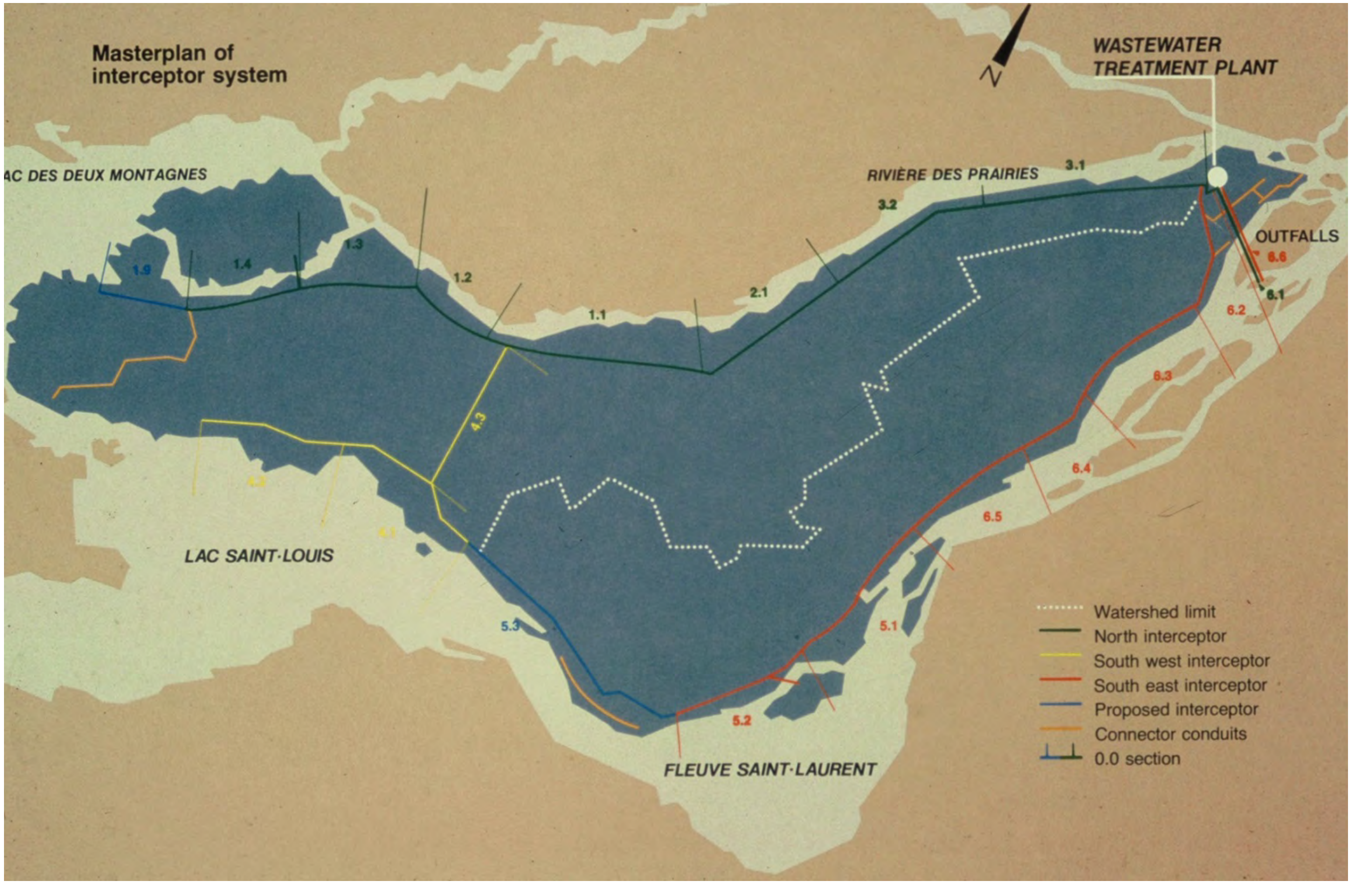
Simplified Ground Support

8 x 11.5 in. Channel Crown Sets at Railroad & Highway Crossings

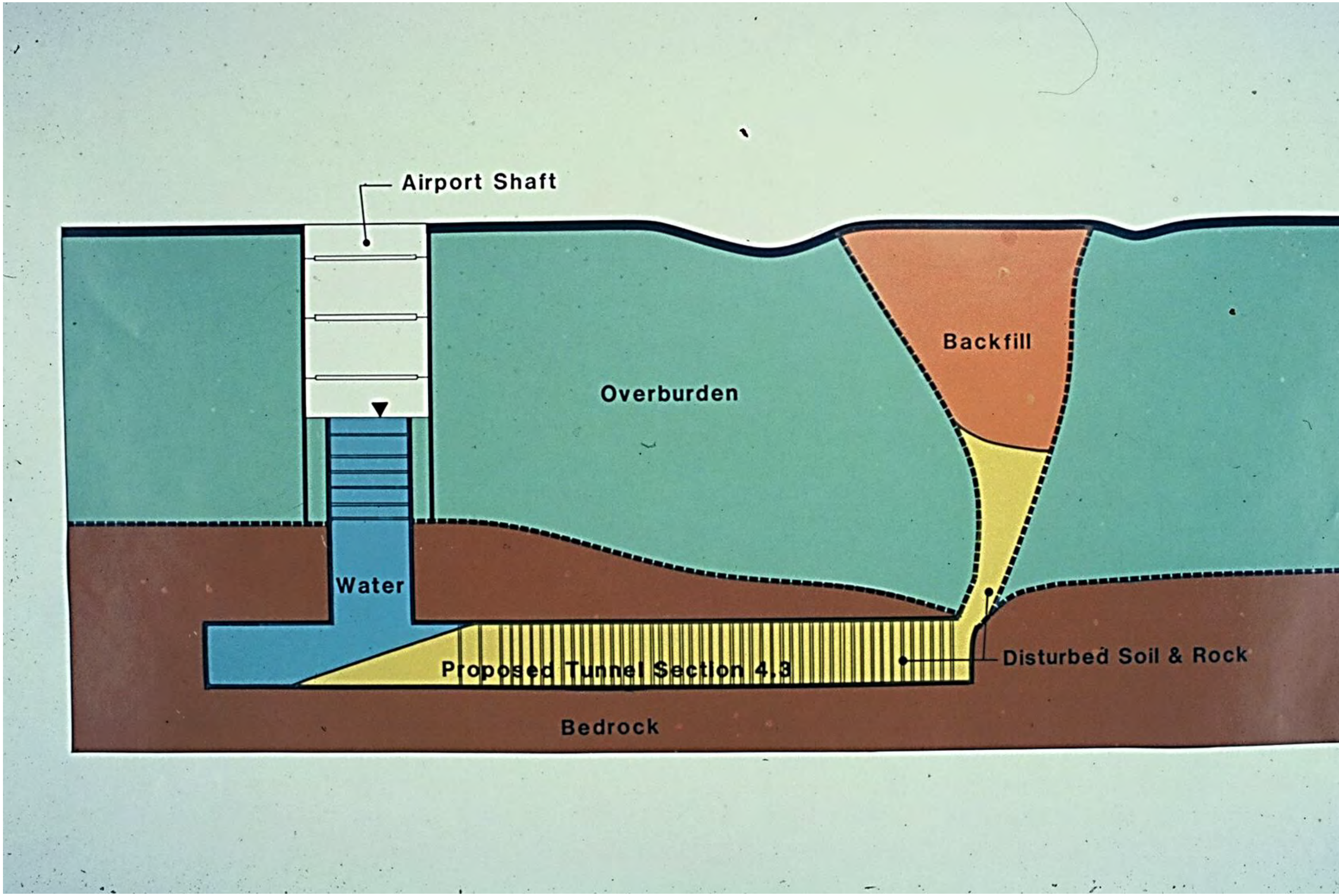
5.5 ft. #8 Resin Grouted Rock dowels and WWF Provide Primary Crown Support

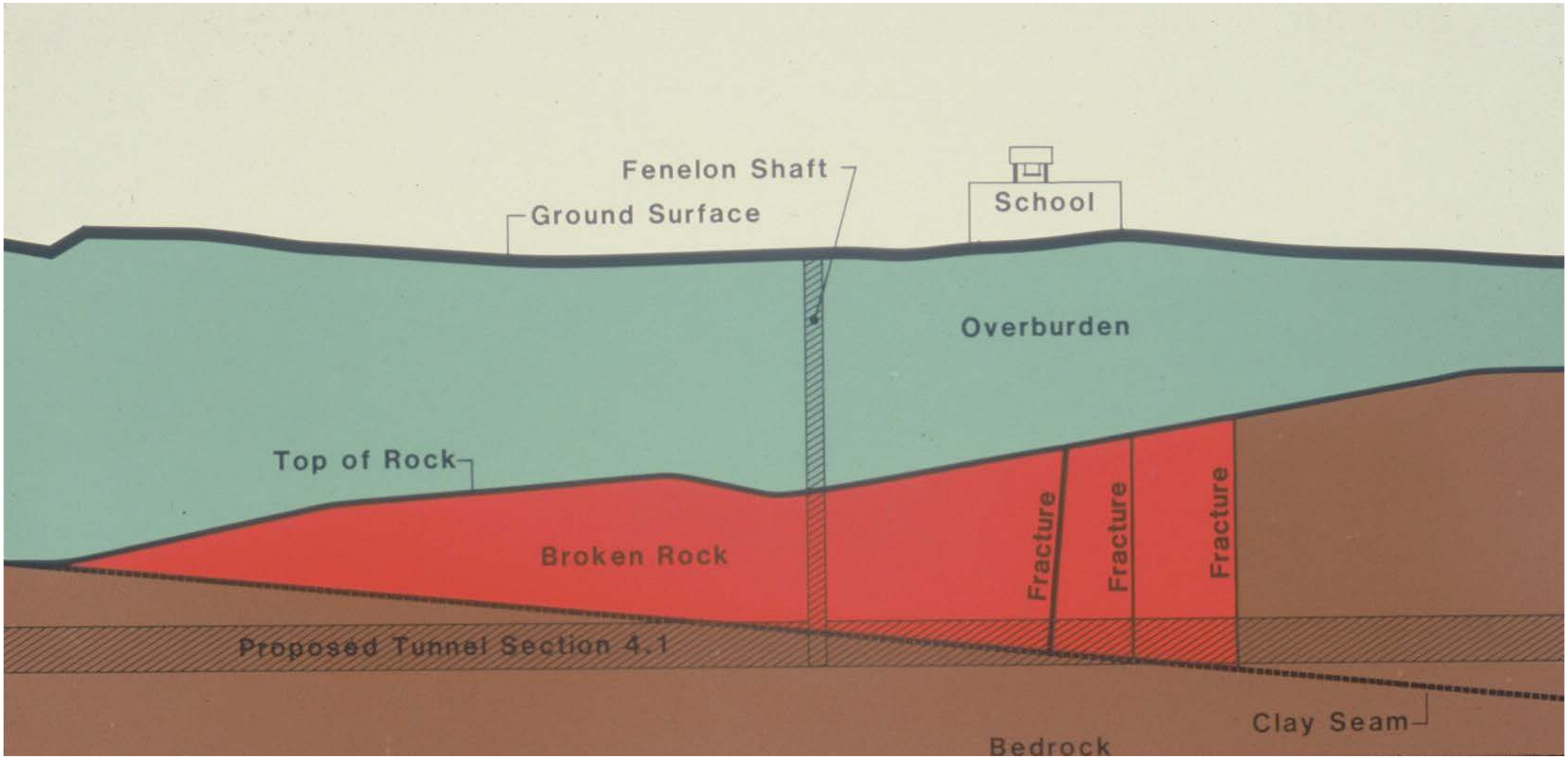
DOCTOR MOLE INCORPORATED

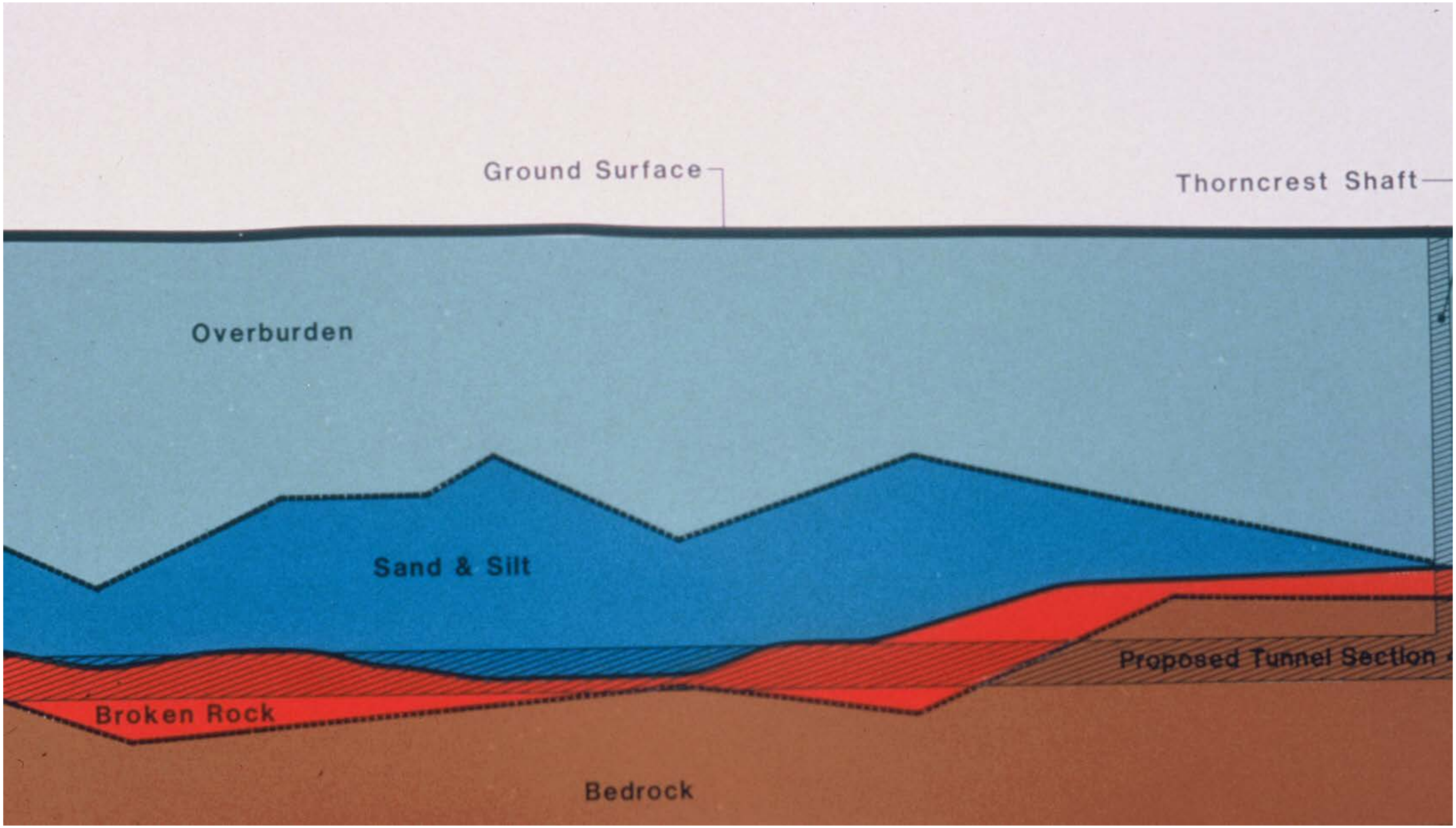
Montreal



Masterplan of interceptor system
WASTEWATER TREATMENT PLANT
AC DES DEUX MONTAGNES
RIVIÈRE DES PRAIRIES
OUTFALLS
LAC SAINT-LOUIS
FLEUVE SAINT-LAURENT
3.1
3.2
2.1
1.1
1.2
1.3
1.4
1.9
4.3
6.6
6.1
6.2
6.3
6.4
6.5
5.1
5.2
5.3
Watershed limit
North interceptor
South west interceptor
South east interceptor
Proposed interceptor
Connector conduits
0.0 section


Airport Shaft
Backfill
Overburden
Water
Proposed Tunnel Section 4.3
Disturbed Soil & Rock
Bedrock


Fenelon Shaft
Ground Surface
School
Overburden
Top of Rock
Broken Rock
Fracture
Fracture
Fracture
Proposed Tunnel Section 4.1
Clay Seam
Bedrock


Ground Surface
Thorncrest Shaft
Overburden
Sand & Silt
Proposed Tunnel Section
Broken Rock
Bedrock

New Crystal Springs Bypass (Polhemus) Tunnel

Design Challenges

By:

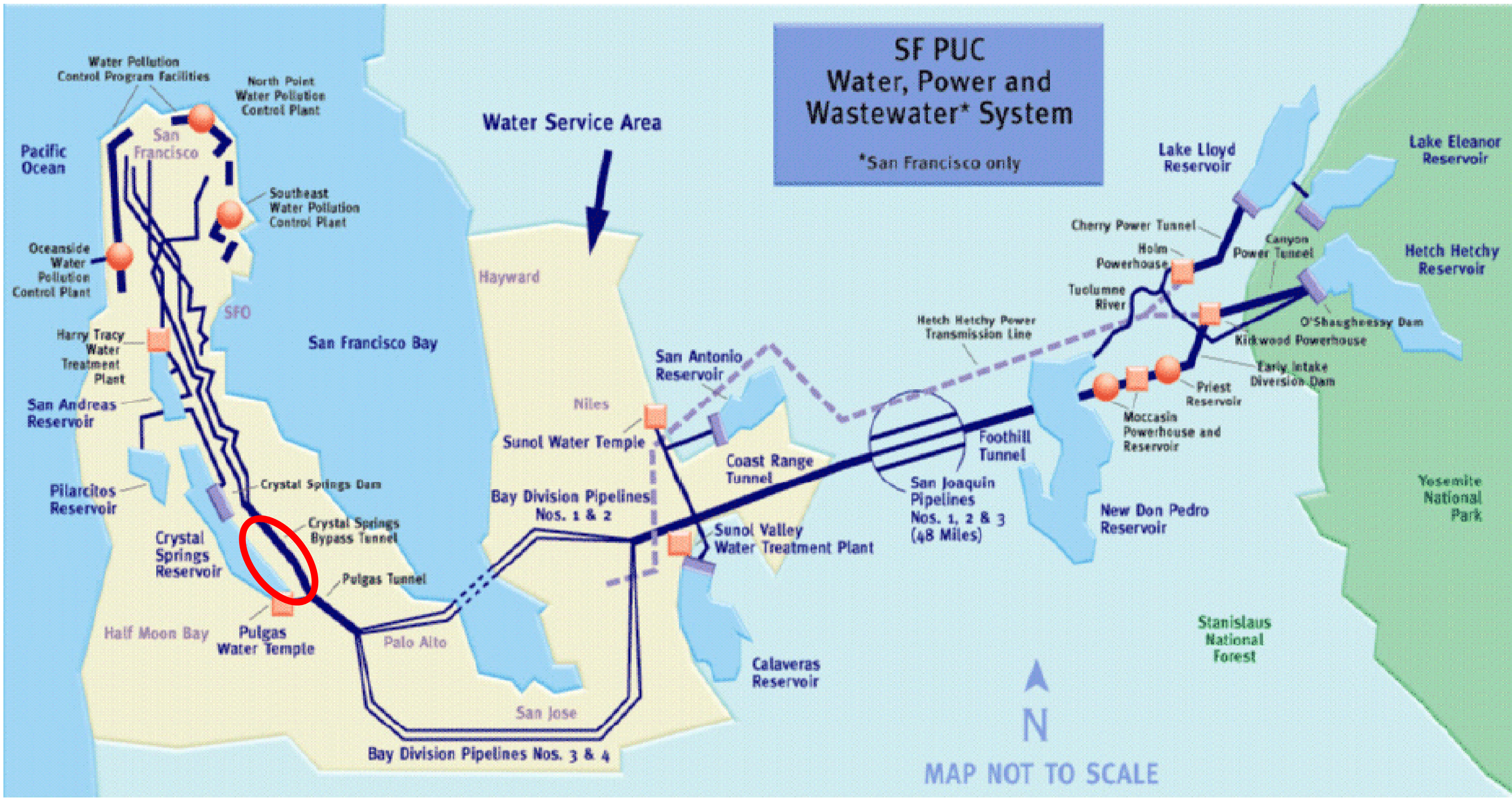
Dr. Gary S. Brierley

City And County Of San Francisco

Public Utilities Commission

San Francisco Water Department

SFPUC
Water Supply Improvement Program



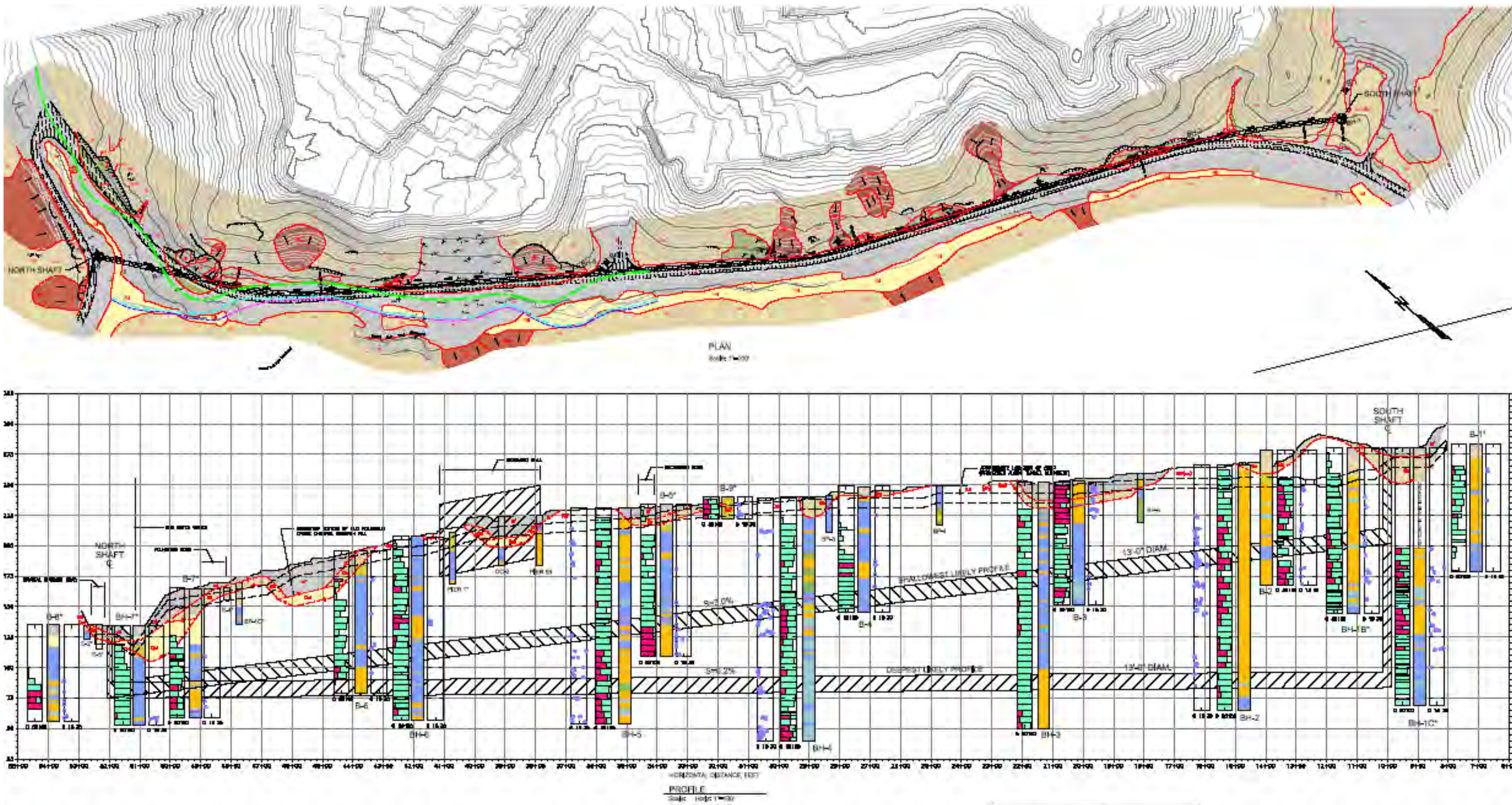
Need for the Project

Project Location

North Shaft | **Landslide area** | **New Tunnel** | **South Shaft Area**

DOCTOR MOLE INCORPORATED

Ground Conditions



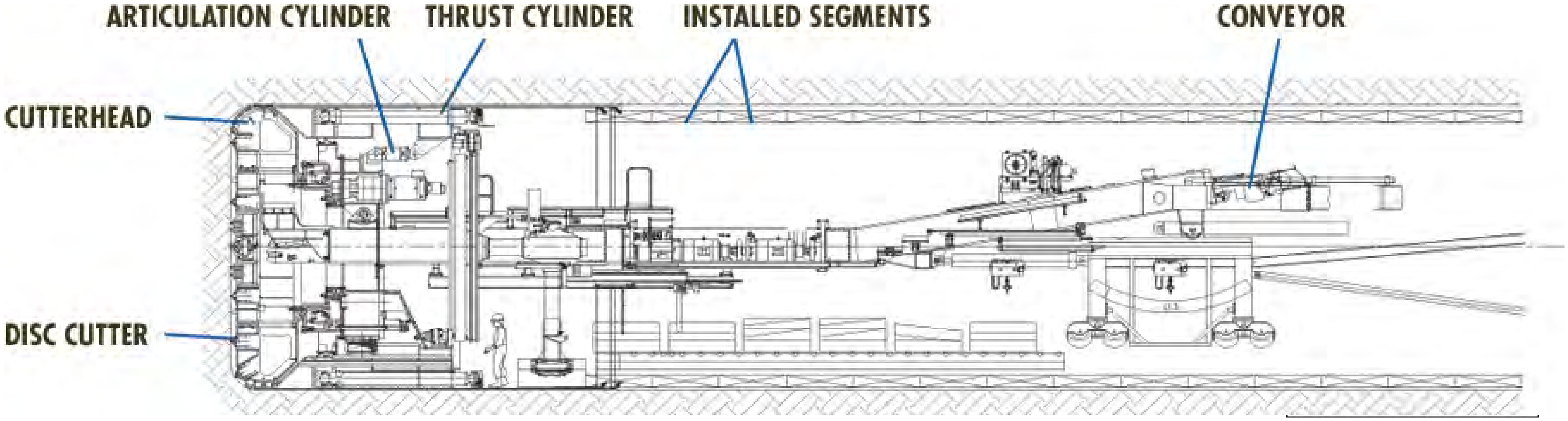
DOCTOR MOLE
INCORPORATED

Ground Conditions

Sandstone

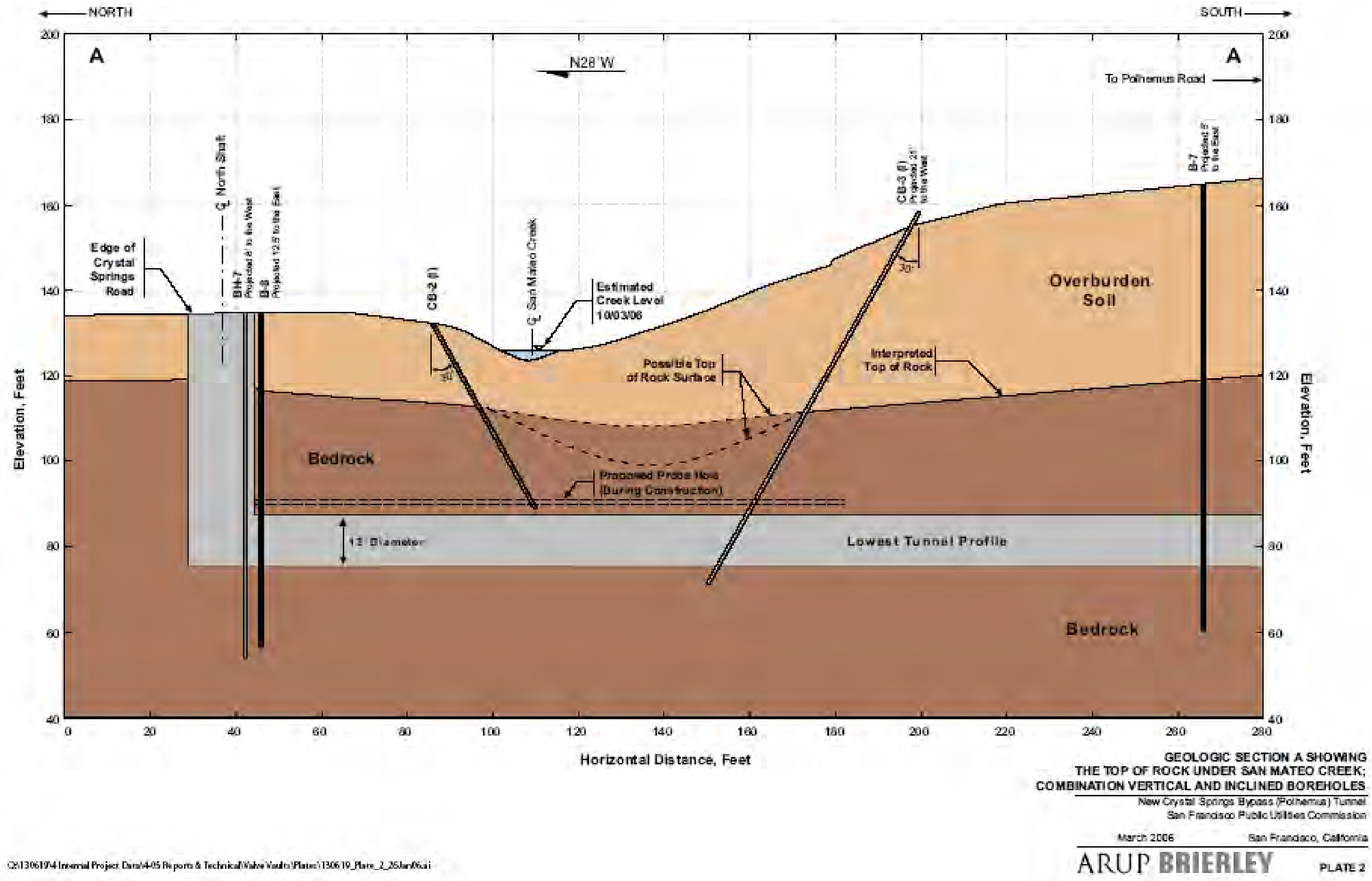
Mélange Matrix

Tunnel Boring Machine



Temporary Tunnel Lining

Crossing San Mateo Creek



DOCTOR MOLE INCORPORATED

DOCTOR MOLE INCORPORATED

A Final Recommendation:

THINK! THINK! THINK!